



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) **EP 1 043 689 A3**

(12) **EUROPEAN PATENT APPLICATION**

(88) Date of publication A3:
16.07.2003 Bulletin 2003/29

(51) Int Cl.7: **G06T 7/00**

(43) Date of publication A2:
11.10.2000 Bulletin 2000/41

(21) Application number: **00303009.5**

(22) Date of filing: **10.04.2000**

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE**
Designated Extension States:
AL LT LV MK RO SI

(72) Inventors:
• **Watanabe, Atsushi**
Suginami-ku, Tokyo 168-0072 (JP)
• **Arimatsu, Taro**
Minamitsuru-gun, Yamanashi 401-0310 (JP)

(30) Priority: **08.04.1999 JP 10188599**

(74) Representative: **Billington, Lawrence Emlyn**
Haseltine Lake & Co.
Imperial House
15-19 Kingsway
London WC2B 6UD (GB)

(71) Applicant: **FANUC LTD**
Minamitsuru-gun, Yamanashi 401-0597 (JP)

(54) **Image processing apparatus**

(57) An image processing apparatus is capable of detecting position and posture of individual workpieces randomly arranged in a pile and having identical shapes. Reference models are created from two-dimensional images of a reference workpiece captured in a plurality of directions by a camera and stored. Also, the relative positions/postures of the workpiece with respect to the camera at the respective image capturing are stored. An image of a pile of workpieces is captured by the camera to obtain a two-dimensional image and the position/posture of the camera at the image capturing is stored. An image of a workpiece matched with one reference

model is selected by matching processing of the reference model with the captured image. A three-dimensional position/posture of the workpiece with respect to the camera is obtained from the image of the selected workpiece, the selected reference model and position/posture information associated with the reference model. A picking-up operation for picking out a respective workpiece from a randomly arranged pile can be performed by a robot, based on the position/posture of the workpiece.

EP 1 043 689 A3



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 30 3009

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	MASAKI I: "INDUSTRIAL VISION SYSTEMS BASED ON APPLICATION-SPECIFIC IC CHIPS" IEICE TRANSACTIONS, INSTITUTE OF ELECTRONICS INFORMATION AND COMM. ENG. TOKYO, JP, vol. E74, no. 6, 1 June 1991 (1991-06-01), pages 1728-1734, XP000262328 ISSN: 0917-1673 * abstract * * page 1728, right-hand column, paragraph 3 - page 1731, left-hand column, paragraph 1 * * figures 1,2 *	1-5,9	G06T7/00
X	MAGEE M ET AL: "An Industrial Model Based Computer Vision System" JOURNAL OF MANUFACTURING SYSTEMS, SOCIETY OF MANUFACTURING ENGINEERS, DEARBORN, MI, US, vol. 14, no. 3, 1995, pages 169-186, XP004002190 ISSN: 0278-6125 * abstract * * page 175, left-hand column, paragraph 3 - page 181, left-hand column, paragraph 3; figures 1-5 *	1-5	TECHNICAL FIELDS SEARCHED (Int.Cl.7) G06K G06T
The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 15 May 2003	Examiner Borotschnig, H
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 30 3009

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	<p>WANG S ET AL: "Model-based vision for robotic manipulation of twisted tubular parts: using affine transforms and heuristic search"</p> <p>ROBOTICS AND AUTOMATION, 1994.</p> <p>PROCEEDINGS., 1994 IEEE INTERNATIONAL CONFERENCE ON SAN DIEGO, CA, USA 8-13 MAY 1994, LOS ALAMITOS, CA, USA, IEEE COMPUT. SOC,</p> <p>8 May 1994 (1994-05-08), pages 208-215, XP010097404</p> <p>ISBN: 0-8186-5330-2</p> <p>* abstract *</p> <p>* page 208, right-hand column, paragraphs 1,2 *</p> <p>* page 208, right-hand column, paragraph 2</p> <p>- page 214, right-hand column, paragraph 3; figures 1-8 *</p> <p>---</p>	1-9	
X	<p>OHBA K ET AL: "Recognition of the multi specularity objects for bin-picking task"</p> <p>INTELLIGENT ROBOTS AND SYSTEMS '96, IROS 96, PROCEEDINGS OF THE 1996 IEEE/RSJ INTERNATIONAL CONFERENCE ON OSAKA, JAPAN 4-8 NOV. 1996, NEW YORK, NY, USA, IEEE, US,</p> <p>4 November 1996 (1996-11-04), pages 1440-1447, XP010212507</p> <p>ISBN: 0-7803-3213-X</p> <p>* abstract *</p> <p>* page 1440, right-hand column, paragraph 2</p> <p>- page 1445, left-hand column, paragraph 4; figures 1,3,8-12 *</p> <p>---</p> <p style="text-align: center;">-/--</p>	1-5,8,9	<p>TECHNICAL FIELDS SEARCHED (Int.Cl.7)</p>
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
MUNICH		15 May 2003	Borotschnig, H
CATEGORY OF CITED DOCUMENTS		<p>T: theory or principle underlying the invention</p> <p>E: earlier patent document, but published on, or after the filing date</p> <p>D: document cited in the application</p> <p>L: document cited for other reasons</p> <p>&: member of the same patent family, corresponding document</p>	
<p>X: particularly relevant if taken alone</p> <p>Y: particularly relevant if combined with another document of the same category</p> <p>A: technological background</p> <p>O: non-written disclosure</p> <p>P: intermediate document</p>			

EPO FORM 1503 (03.02) (P44311)



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 30 3009

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X,P	AMANO T ET AL: "EIGENSPACE APPROACH FOR OBJECT RECOGNITION AND ITS POSE DETECTION" SYSTEMS & COMPUTERS IN JAPAN, SCRIPTA TECHNICA JOURNALS. NEW YORK, US, vol. 31, no. 11, October 2000 (2000-10), pages 60-69, XP000976216 ISSN: 0882-1666	1-4,6-9	
X	& AMANO T ET AL: "Eigenspace approach for object recognition and its pose detection" DENSHI JOHO TSUSHIN GAKKAI RONBUNSHI, vol. J82-D-II, no. 2, 1 February 1999 (1999-02-01), pages 250-258, * the whole document *	1-4,6-9	
X	HORNEGGER J ET AL: "Statistical learning, localization, and identification of objects" COMPUTER VISION, 1995. PROCEEDINGS., FIFTH INTERNATIONAL CONFERENCE ON CAMBRIDGE, MA, USA 20-23 JUNE 1995, LOS ALAMITOS, CA, USA, IEEE COMPUT. SOC, US, 20 June 1995 (1995-06-20), pages 914-919, XP010146971 ISBN: 0-8186-7042-8 * abstract * * page 915, left-hand column, paragraph 2 - page 919, left-hand column, paragraph 1; figures 1-8 *	1-5,9	
X	GB 2 085 629 A (MICRO COSULTANTS LTD) 28 April 1982 (1982-04-28) * abstract * * page 1, line 43 - line 53 * * page 2, line 1 - page 4, line 17; figure 1 * --- -/--	1-5,8,9	
The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 15 May 2003	Examiner Borotschnig, H
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EPO FORM 1503 03.82 (P04C01)



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 30 3009

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 5 845 048 A (MASUMOTO DAIKI) 1 December 1998 (1998-12-01) * abstract * * column 2, line 6,7 * * column 3, line 52 - column 4, line 63 * * column 6, line 26 - line 67 * * column 12, line 37 - column 24, line 67; figures 2,5,6,10,13 * ---	1-9	
X,P	WEBSTER J. G. ED.: "Wiley Encyclopedia of Electrical and Electronics Engineering, Supplement 1, Object Recognition" 1 April 2000 (2000-04-01) , JOHN WILEY & SONS, INC. XP002241335 ISBN: 0-471-35895-9 * page 449 - page 470 * -----	1-9	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
Place of search MUNICH		Date of completion of the search 15 May 2003	Examiner Borotschnig, H
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document</p> <p>T: theory or principle underlying the invention E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons &: member of the same patent family, corresponding document</p>			

EPO FORM 1503 (03.02 (P04C01))

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 00 30 3009

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

15-05-2003

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
GB 2085629	A	28-04-1982	US	4486775 A	04-12-1984
US 5845048	A	01-12-1998	JP	8212329 A	20-08-1996

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82